HOMEWORK I – CURVES MODELLING

COMPUTER GRAPHICS

Surname	First name	Evaluation

1 Curves modelling in Rhinoceros

1.1 Write the first letter of your name in Rhinoceros by means of one clamped curve. Design a curved font by yourself. Use *Control point curve* command, degree = 3, grid = 6 mm, $n \geq 9$.

1.2 Draw all knots of the clamped curve. Use *Multiple point* command with activated *Knots object snap*.

1.3 Construct all control points of all Bézier curves creating the clamped curve.

1.4 Draw all Bézier curves.

1.5 Choose any segment that **is Coons cubic curve** and change the colour of this segment. Move all the constructed figures to identify the first control point of this Coons cubic curve with origin of coordinate system.

2 Drawings and calculations

2.1 **Drawing 1:**
Draw axes of coordinate system and label scales.
Construct control polygon $\mathbf{P}_0\mathbf{P}_1 \cdots$ of the clamped curve drawn in section 1.
Construct knots $\mathbf{Q}_0, \mathbf{Q}_1, \cdots$ of curve segments $k_0, k_1, \cdots$ of the clamped curve.
Construct tangent vectors $\mathbf{q}_0, \mathbf{q}_1, \cdots$ at knots $\mathbf{Q}_0, \mathbf{Q}_1, \cdots$ of the clamped curve.
Sketch the clamped curve.
Designate all elements in the picture.

2.2 Indicate by different colour the legs of control polygon of the clamped curve creating control polygon of Coons cubic B-spline and corresponding curve segments creating Coons cubic B-spline.

2.3 Designate by $\widetilde{\mathbf{P}}_0, \widetilde{\mathbf{P}}_1, \widetilde{\mathbf{P}}_2, \widetilde{\mathbf{P}}_3$ the control points of Coons cubic curve chosen in section 1.5.
Write their coordinates:

$\widetilde{\mathbf{P}}_0 = (0,0)$	$\widetilde{\mathbf{P}}_1 =$	$\widetilde{\mathbf{P}}_2 =$	$\widetilde{\mathbf{P}}_3 =$

2.4 Suppose the Coons cubic curve chosen in section 1.5 is Bézier cubic curve $\mathbf{P}(t)$ given by control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$. Calculate their coordinates:

$\mathbf{V}_0 =$	$\mathbf{V}_1 =$	$\mathbf{V}_2 =$	$\mathbf{V}_3 =$

2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t),\ t \in [0,1]$ and its tangent vector $\mathbf{P}'(t),\ t \in [0,1]$. Calculate coordinates of point $\mathbf{P}\left(\frac{1}{2}\right)$ and coordinates of tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}\left(\frac{1}{2}\right) =$
$\mathbf{P}'(t) = (x'(t), y'(t)) =$	$\mathbf{P}'\left(\frac{1}{2}\right) =$

2.6 **Drawing 2:**
In appropriate size, construct axes of coordinate system and label scales.
Construct control polygon $\widetilde{\mathbf{P}}_0\widetilde{\mathbf{P}}_1\widetilde{\mathbf{P}}_2\widetilde{\mathbf{P}}_3$.
Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.
Use de Casteljau algorithm and construct point $\mathbf{P}\left(\frac{1}{2}\right)$ and tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$.
Sketch Bézier cubic curve $\mathbf{P}(t)$.
Designate all elements in the picture.

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Construct tangent vectors $\mathbf{q}_0, \mathbf{q}_1, \cdots$ at knots $\mathbf{Q}_0, \mathbf{Q}_1, \cdots$ of the clamped curve.
Sketch the clamped curve.
Designate all elements in the picture.

2.2 Indicate by different colour the legs of control polygon of the clamped curve creating control polygon of Coons cubic B-spline and corresponding curve segments creating Coons cubic B-spline.

2.3 Designate by $\widetilde{\mathbf{P}}_0, \widetilde{\mathbf{P}}_1, \widetilde{\mathbf{P}}_2, \widetilde{\mathbf{P}}_3$ the control points of Coons cubic curve chosen in section 1.5.
Write their coordinates:

$\widetilde{\mathbf{P}}_0 = (0,0)$	$\widetilde{\mathbf{P}}_1 =$	$\widetilde{\mathbf{P}}_2 =$	$\widetilde{\mathbf{P}}_3 =$

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$\mathbf{V}_0 =$	$\mathbf{V}_1 =$	$\mathbf{V}_2 =$	$\mathbf{V}_3 =$

2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t), t \in [0,1]$ and its tangent vector $\mathbf{P}'(t), t \in [0,1]$. Calculate coordinates of point $\mathbf{P}(\frac{1}{2})$ and coordinates of tangent vector $\mathbf{P}'(\frac{1}{2})$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}(\frac{1}{2}) =$
$\mathbf{P}'(t) = (x'(t), y'(t)) =$	$\mathbf{P}'(\frac{1}{2}) =$

2.6 **Drawing 2:**
In appropriate size, construct axes of coordinate system and label scales.
Construct control polygon $\widetilde{\mathbf{P}}_0\widetilde{\mathbf{P}}_1\widetilde{\mathbf{P}}_2\widetilde{\mathbf{P}}_3$.
Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.
Use de Casteljau algorithm and construct point $\mathbf{P}(\frac{1}{2})$ and tangent vector $\mathbf{P}'(\frac{1}{2})$.
Sketch Bézier cubic curve $\mathbf{P}(t)$.
Designate all elements in the picture.

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$\widetilde{\mathbf{P}}_0 = (0,0)$	$\widetilde{\mathbf{P}}_1 =$	$\widetilde{\mathbf{P}}_2 =$	$\widetilde{\mathbf{P}}_3 =$

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2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t),\ t \in [0,1]$ and its tangent vector $\mathbf{P}'(t),\ t \in [0,1]$. Calculate coordinates of point $\mathbf{P}\left(\frac{1}{2}\right)$ and coordinates of tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}\left(\frac{1}{2}\right) =$
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2.6 **Drawing 2:**
In appropriate size, construct axes of coordinate system and label scales.
Construct control polygon $\widetilde{\mathbf{P}}_0\widetilde{\mathbf{P}}_1\widetilde{\mathbf{P}}_2\widetilde{\mathbf{P}}_3$.
Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.
Use de Casteljau algorithm and construct point $\mathbf{P}\left(\frac{1}{2}\right)$ and tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$.
Sketch Bézier cubic curve $\mathbf{P}(t)$.
Designate all elements in the picture.

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2.4 Suppose the Coons cubic curve chosen in section 1.5 is Bézier cubic curve $\mathbf{P}(t)$ given by control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$. Calculate their coordinates:

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2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t),\ t \in [0,1]$ and its tangent vector $\mathbf{P}'(t),\ t \in [0,1]$. Calculate coordinates of point $\mathbf{P}\left(\frac{1}{2}\right)$ and coordinates of tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}\left(\frac{1}{2}\right) =$
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2.6 **Drawing 2:**
In appropriate size, construct axes of coordinate system and label scales.
Construct control polygon $\widetilde{\mathbf{P}}_0\widetilde{\mathbf{P}}_1\widetilde{\mathbf{P}}_2\widetilde{\mathbf{P}}_3$.
Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.
Use de Casteljau algorithm and construct point $\mathbf{P}\left(\frac{1}{2}\right)$ and tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$.
Sketch Bézier cubic curve $\mathbf{P}(t)$.
Designate all elements in the picture.

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HOMEWORK I – CURVES MODELLING

COMPUTER GRAPHICS

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Construct tangent vectors $\mathbf{q}_0, \mathbf{q}_1, \cdots$ at knots $\mathbf{Q}_0, \mathbf{Q}_1, \cdots$ of the clamped curve.

Sketch the clamped curve.

Designate all elements in the picture.

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2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t),\, t \in [0,1]$ and its tangent vector $\mathbf{P}'(t),\, t \in [0,1]$. Calculate coordinates of point $\mathbf{P}\left(\frac{1}{2}\right)$ and coordinates of tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}\left(\frac{1}{2}\right) =$
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2.6 **Drawing 2:**

In appropriate size, construct axes of coordinate system and label scales.

Construct control polygon $\widetilde{\mathbf{P}}_0\widetilde{\mathbf{P}}_1\widetilde{\mathbf{P}}_2\widetilde{\mathbf{P}}_3$.

Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.

Use de Casteljau algorithm and construct point $\mathbf{P}\left(\frac{1}{2}\right)$ and tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$.

Sketch Bézier cubic curve $\mathbf{P}(t)$.

Designate all elements in the picture.

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COMPUTER GRAPHICS

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2.4 Suppose the Coons cubic curve chosen in section 1.5 is Bézier cubic curve $\mathbf{P}(t)$ given by control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$. Calculate their coordinates:

$\mathbf{V}_0 =$	$\mathbf{V}_1 =$	$\mathbf{V}_2 =$	$\mathbf{V}_3 =$

2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t),\ t \in [0,1]$ and its tangent vector $\mathbf{P}'(t),\ t \in [0,1]$. Calculate coordinates of point $\mathbf{P}(\frac{1}{2})$ and coordinates of tangent vector $\mathbf{P}'(\frac{1}{2})$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}(\frac{1}{2}) =$
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2.6 **Drawing 2:**
In appropriate size, construct axes of coordinate system and label scales.
Construct control polygon $\widetilde{\mathbf{P}}_0\widetilde{\mathbf{P}}_1\widetilde{\mathbf{P}}_2\widetilde{\mathbf{P}}_3$.
Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.
Use de Casteljau algorithm and construct point $\mathbf{P}(\frac{1}{2})$ and tangent vector $\mathbf{P}'(\frac{1}{2})$.
Sketch Bézier cubic curve $\mathbf{P}(t)$.
Designate all elements in the picture.

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2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t),\ t \in [0,1]$ and its tangent vector $\mathbf{P}'(t),\ t \in [0,1]$. Calculate coordinates of point $\mathbf{P}\left(\frac{1}{2}\right)$ and coordinates of tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}\left(\frac{1}{2}\right) =$
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Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.
Use de Casteljau algorithm and construct point $\mathbf{P}\left(\frac{1}{2}\right)$ and tangent vector $\mathbf{P}'\left(\frac{1}{2}\right)$.
Sketch Bézier cubic curve $\mathbf{P}(t)$.
Designate all elements in the picture.

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$\mathbf{V}_0 =$	$\mathbf{V}_1 =$	$\mathbf{V}_2 =$	$\mathbf{V}_3 =$

2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t),\ t \in [0,1]$ and its tangent vector $\mathbf{P}'(t),\ t \in [0,1]$. Calculate coordinates of point $\mathbf{P}(\frac{1}{2})$ and coordinates of tangent vector $\mathbf{P}'(\frac{1}{2})$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}(\frac{1}{2}) =$
$\mathbf{P}'(t) = (x'(t), y'(t)) =$	$\mathbf{P}'(\frac{1}{2}) =$

2.6 **Drawing 2:**
In appropriate size, construct axes of coordinate system and label scales.
Construct control polygon $\widetilde{\mathbf{P}}_0\widetilde{\mathbf{P}}_1\widetilde{\mathbf{P}}_2\widetilde{\mathbf{P}}_3$.
Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.
Use de Casteljau algorithm and construct point $\mathbf{P}(\frac{1}{2})$ and tangent vector $\mathbf{P}'(\frac{1}{2})$**.**
Sketch Bézier cubic curve $\mathbf{P}(t)$.
Designate all elements in the picture.

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1 Curves modelling in Rhinoceros

1.1 Write the first letter of your name in Rhinoceros by means of one clamped curve. Design a curved font by yourself. Use *Control point curve* command, degree = 3, grid = 6 mm, $n \geq 9$.

1.2 Draw all knots of the clamped curve. Use *Multiple point* command with activated *Knots object snap*.

1.3 Construct all control points of all Bézier curves creating the clamped curve.

1.4 Draw all Bézier curves.

1.5 Choose any segment that **is Coons cubic curve** and change the colour of this segment. Move all the constructed figures to identify the first control point of this Coons cubic curve with origin of coordinate system.

2 Drawings and calculations

2.1 **Drawing 1:**
Draw axes of coordinate system and label scales.
Construct control polygon $\mathbf{P}_0\mathbf{P}_1 \cdots$ of the clamped curve drawn in section 1.
Construct knots $\mathbf{Q}_0, \mathbf{Q}_1, \cdots$ of curve segments $k_0, k_1, \cdots$ of the clamped curve.
Construct tangent vectors $\mathbf{q}_0, \mathbf{q}_1, \cdots$ at knots $\mathbf{Q}_0, \mathbf{Q}_1, \cdots$ of the clamped curve.
Sketch the clamped curve.
Designate all elements in the picture.

2.2 Indicate by different colour the legs of control polygon of the clamped curve creating control polygon of Coons cubic B-spline and corresponding curve segments creating Coons cubic B-spline.

2.3 Designate by $\widetilde{\mathbf{P}}_0, \widetilde{\mathbf{P}}_1, \widetilde{\mathbf{P}}_2, \widetilde{\mathbf{P}}_3$ the control points of Coons cubic curve chosen in section 1.5.
Write their coordinates:

$\widetilde{\mathbf{P}}_0 = (0,0)$	$\widetilde{\mathbf{P}}_1 =$	$\widetilde{\mathbf{P}}_2 =$	$\widetilde{\mathbf{P}}_3 =$

2.4 Suppose the Coons cubic curve chosen in section 1.5 is Bézier cubic curve $\mathbf{P}(t)$ given by control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$. Calculate their coordinates:

$\mathbf{V}_0 =$	$\mathbf{V}_1 =$	$\mathbf{V}_2 =$	$\mathbf{V}_3 =$

2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t),\ t \in [0,1]$ and its tangent vector $\mathbf{P}'(t),\ t \in [0,1]$. Calculate coordinates of point $\mathbf{P}(\frac{1}{2})$ and coordinates of tangent vector $\mathbf{P}'(\frac{1}{2})$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}(\frac{1}{2}) =$
$\mathbf{P}'(t) = (x'(t), y'(t)) =$	$\mathbf{P}'(\frac{1}{2}) =$

2.6 **Drawing 2:**
In appropriate size, construct axes of coordinate system and label scales.
Construct control polygon $\widetilde{\mathbf{P}}_0\widetilde{\mathbf{P}}_1\widetilde{\mathbf{P}}_2\widetilde{\mathbf{P}}_3$.
Construct control points $\mathbf{V}_0, \mathbf{V}_1, \mathbf{V}_2, \mathbf{V}_3$.
Use de Casteljau algorithm and construct point $\mathbf{P}(\frac{1}{2})$ and tangent vector $\mathbf{P}'(\frac{1}{2})$.
Sketch Bézier cubic curve $\mathbf{P}(t)$.
Designate all elements in the picture.

- Use fractions, if necessary. Do not use decimal numbers.
- This is a title page of homework. Staple all sheets with computations and drawing (or put them into a transparent envelope) and hand in on the next lesson.

HOMEWORK I – CURVES MODELLING
COMPUTER GRAPHICS

Surname	First name	Evaluation

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Write their coordinates:

$\widetilde{\mathbf{P}}_0 = (0,0)$	$\widetilde{\mathbf{P}}_1 =$	$\widetilde{\mathbf{P}}_2 =$	$\widetilde{\mathbf{P}}_3 =$

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$\mathbf{V}_0 =$	$\mathbf{V}_1 =$	$\mathbf{V}_2 =$	$\mathbf{V}_3 =$

2.5 Find vector equation of Bézier cubic curve $\mathbf{P}(t), t \in [0,1]$ and its tangent vector $\mathbf{P}'(t), t \in [0,1]$. Calculate coordinates of point $\mathbf{P}(\frac{1}{2})$ and coordinates of tangent vector $\mathbf{P}'(\frac{1}{2})$:

$\mathbf{P}(t) = (x(t), y(t)) =$	$\mathbf{P}(\frac{1}{2}) =$
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In appropriate size, construct axes of coordinate system and label scales.
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